

## **Log-made Truss Structural Member**

### **Technical Field**

[0001]The present invention relates to a log-made truss structural member and, more particularly, to a structural member made of a log which is also applicable to a large-scale truss structure, so that a log may be joined as a truss member to connector nodes with high accuracy in spite of the fact that the main body of the member is made of wood.

### **Background**

[0002]A structural member made of a log is much less than one made of steel on the characteristics of strength, toughness and durability over a long period of time. Moreover, it substantially cannot be manufactured exactly in length, which is different from steel-made products.

[0003]A screw type joint device for joining a truss structure to connector nodes is disclosed in German Patent No. 901,955 and in U.S. Patent no.4,872,779. However, such joint devices are shown as metallic products applied to hollow steel pipes only, with no consideration of the application to solid logs.

[0004] A hard kind of wood with a high density is generally used to manufacture wooden structural members. It is especially required that wooden structural members used in a truss structure and/or brace structure do not deform easily under any load, so the wood should be

well-dried and/or large in diameter, and further, homogeneous, so as to deform as impartially as possible. The construction of a truss structure with high precision in length has always forced the use of metallic joint devices of the screw type.

[0005] In constructing roofs and/or walls of a gymnasium, large hall and the like by using a truss structure, a large number of structural members are required. However, it is not often possible to use only thick wood with high density as well as high strength and rigidity from the viewpoint of the quantity and the costs. This results in attempting to use comparatively thin logs, such as the structural member with high joining strength found in JP2003-74125A1.

[0006] The wooden structural member mainly comprises a log 2, a screw type joint device 30, a connector 4 and lag screws 5 as shown in Fig.9 which is a sectional view of one side part thereof. The joint device 30 for joining the member to connector node 8 is almost the same as the one disclosed in U.S. Patent no. 4,872,779 mentioned above.

[0007] A connector 4 comprises a first element 4A occupying one half of a node side thereof and a second element 4B which engages with the former, occupying another half of a counter-node side thereof. The connector is fixed not only to the joint device 30 for joining a truss structural member 31 to the connector node 8 but also tightly to a butt end 2A of a log 2 by several big and thick lag screws 5 though one lag screw only is shown in Fig.9. The connector and the joint device have enabled constructing large-scale roofs and large-scale walls having wooden truss structures.

[0008]A projection 2B like a truncated cone is shaped on both butt ends 2A of the log 2 by machining on a lathe. A tapered portion 2m, whose diameter is designed to be smaller to the end of a node side, is formed around the projection 2B so as to be covered by the connector 4. Not only undersized holes 9 for advancing lag screws are bored in the butt ends 2A before hand but oversized passage 4f for the lag screws are drilled through the second element 4B.

[0009]The first element 4A has a supporter for holding slidably the shank 6m of the fastening bolt 6 at the end of the node side thereof and an annular projection 4n engaging tightly with the projection 2B at the end of a counter-node side thereof. Pressing the butt end 2A in both radial and circumferential directions thereof, owing to the end of a counter-node side of connector 4, restrains the butt end from cracking and expanding while a lag screw advances and stays in the log, resulting in facilitating a strong engagement of lag screws with the log so as to maintain a durable connection of connector 4 to log 2. Large and/or plural lag screws improve the reliability and the stability of wooden structures and contribute to the continued development of large-scale wooden truss structures.

[0010]The connectors can be manufactured to desired shapes and size with high accuracy because they are made of metal which can be easily machined. However, it is almost impossible to cut a log exactly in size. Manufacturing a log with high accuracy requires lots of working time, great technical skill, complicated working and high quality, making it nearly impossible to make truss structural members economically by

using ordinary logs that are easy to obtain.

[0011] In the structural member of Fig. 9, it is important to make a projection 2B of a circumference which is held by the annular projection 4n exactly in size. However, the provisional center established on the basis of the whole of a log often results in giving not only the projection 2B a slightly wrong position and an incorrect contour but the tapered portion 2n a wrong shape, being different from an exact center established in metallic machined products. An undesirable clearance appears between the circumference of projection 2B and the connector 4 even if the latter is manufactured with high accuracy in size. Therefore, the engagement of the connector with the butt end becomes weak in the radial and circumferential directions thereof.

[0012]The annular projection 4n mentioned above can prevent cracks occurring around the lag screws 5 from extending toward the periphery of the butt end. Since the circumference of projection 2B is held by it, however, there are no obstacles for stopping cracks before they reach the annular projection 2B. The higher the number of lag screws used, the more serious the cracks tend to become on the butt ends. Therefore, the butt ends result in a decrease in strength.

[0013]The joint device 30 shown in Fig.9 has a coiled spring 32 installed on the shank 6m of the fastening bolt 6, so that the coiled spring can project from the end of fastening threaded portion 6a from the sleeve 7, since it biases the fastening bolt whenever it is retracted toward the connector. The sleeve 7 inconveniently comes off the fastening bolt, depending on an attitude of a truss structural member 31 because it only

covers a fastening bolt 6. Such a behavior will be avoided if a pin 11 for preventing the sleeve from coming off a fastening bolt is disposed on the sleeve in the direction of a radius thereof. However, the pin is inapplicable in consideration that a head of the pin will disturb the expansion and contraction of the coiled spring 32.

[0014]A complicated fastening bolt 6 provided with a hexagonal boss 6p for the above-mentioned joint device is not an ordinary bolt found on the market as a standard industrial product. Accordingly, such a fastening bolt will become remarkably expensive since a stopper 6s, a shank 6m, boss 6p and a fastening threaded portion 6a must be formed by machining an original bar of steel.

[0015]The first object of the present invention relating to a log-made truss structural member is to propose a structural member not only having high size performance but keeping the original strength of the log even if the log is just cut off on both ends thereof. The second object is to restrict the deterioration and weathering of the butt ends where a screw type joint device is fitted. The third object is to enable a big axial force to be introduced into a structural member by using a large-diameter lag screw and/or plural screws to install joint devices on a log, and the fourth object is to improve the reliability and stability of a large-scale wooden truss structure.

[0016]More particularly, in the present invention it is important to decrease the complicated machining procedures and highly precise machining necessary to suppress the cracks occurring on the butt ends and their progress, i.e., to propose a new connector not only for

installing a joint device to the butt end with high accuracy but holding the butt end tightly without any clearance.

[0017]A further object is to prevent as many cracks occurring on the butt ends as possible even when plural lag screws are used. This is aimed at restraining the progress of cracks bridging between lag screws close to each other under the state that the butt end is already held at its periphery.

[0018]Furthermore, another three objects are as follows; the first is to propose a connector also available to the screw type joint device having another transmission mechanism for rotating the fastening bolt even when the device is applied to a log. The second is to propose mechanisms not only for preventing a sleeve from coming off the fastening bolt but for automatically restoring the bolt being pushed into the sleeve. The third is to enable a screw type joint device to be made at a low price by using an ordinary bolt already on the market as a standard industrial product as the fastening bolt.

### Summary of the Invention

[0019] The present invention as applied to a truss structural member provides screw type joint devices on both ends of a log, which have a fastening bolt engaged with a screw hole of connector nodes. Referring to Fig.1, the truss structural member 1 comprises a log 2 cut so as to form flat surfaces on butt ends 2A thereof, a connector 4 having not only a supporting hole 4a which slidably holds the shank 6m of the fastening bolt 6 at the end of a node side thereof but a contacting surface 4b which

is seated on the butt end 2A at the end of a counter-node side thereof, and lag screws 5 advancing against the log 2 to fix the connector 4 to the butt end 2A of the log. The connector 4 is composed of a first element 4A with said supporting hole 4a, occupying one half of a node side thereof, and a second element 4B with said contacting surface 4b, occupying another half, which engage with the first element 4A. The first element 4A is provided with an axial symmetrical part making a space 4s to accommodate a part of said fastening bolt 6 retracted through the supporting hole on the side of counter-node thereof and a connecting threaded portion 4d formed at the end of counter-node side of said axial symmetrical part making the space 4s. The second element as 4B is a metallic seat provided with bores 4f as large as the threaded portion of said lag screw which passes through, which has not only a threaded part 4g engaged with the connecting threaded portion 4d on the node side thereof but one or plural annular thorns 4c driven into the butt end 2A under a pressure load on the counter-node side thereof. The screw type joint device 3 is provided with said fastening bolt 6 and a sleeve 7 for covering the fastening bolt 6. The former has not only a fastening threaded portion 6a on the node side thereof but a stopper 6s contacting the internal end surface of said first element 4A on the counter-node side thereof and the latter has a sleeve hole 7a not only for transmitting rotational torque to the fastening bolt 6 but for sliding the bolt 6 in the direction of axis thereof.

[0020]The neck of a lag screw is surrounded by an auxiliary thorny ring 12 on the contacting surface of the second element 4B and the butt end 2A of the log. The auxiliary thorny ring 12 can be made as a sole part independent of the second element 4B or an auxiliary annular thorn as an

auxiliary thorny ring may be formed on the contacting surface 4b of the second element 4B as shown in Fig.5.

[0021]Referring to Fig.1 again, the screw type joint device 3 has a fastening bolt 6 provided with a polygonal boss 6p on the node side of the shank 6m thereof away from the first element 4A so as to transmit the rotational torque from the sleeve 7 to the fastening bolt owing to inserting the boss 6p into the sleeve hole 7a.

[0022]As shown in Fig.3, a high tensile bolt 6A already on the market is used as the fastening bolt 6 and its bolt head is assigned to the stopper 6s.

[0023]As shown in Fig.2(a), the boss 6p is formed by bonding a polygonal cylinder 13 having a round bore 13a, manufactured as a sole parts, around the shank 6m of the high tensile bolt 6A. Or as shown in Fig.2(b), the boss is formed by bonding a polygonal cylinder 13 having a threaded aperture 13b, manufactured as a sole part, around the threaded end of counter-node side of the fastening threaded portion 6a after engaging with each other.

[0024] The sleeve 7 covering said boss 6p is provided with a pin 11 shown in Fig.1 for preventing the sleeve 7 from coming off a fastening bolt 6 by contacting the pin to the end of counter-node side of the boss 6p.

[0025] Referring to Fig.7, a screw type joint device 3B has a sleeve 7A provided with a slit 7b extending along the longitudinal axis thereof and a



fastening bolt 6 provided with a rod 7c extending in the radial direction thereof through the slit for transmitting rotational torque from the sleeve to the fastening bolt.

[0026] As shown in Fig.1, an elastic matter 10 (see 10B in Fig.7) for biasing the fastening bolt 6 toward a screw hole of the connector node is disposed in the space 4s of the first element 4A for accommodating a part of the fastening bolt retracted through the supporting hole.

[0027] According to the present invention, a connector comprises a first element slidably holding a shank of a fastening bolt and a second element engaged with the end of a counter-node side of the first element under the state that it is tightly fixed on the butt end of a log by lag screws disposed at the end of the log, so that a screw type joint device which was used with a steel pipe structural member can be used with wooden structural members such as a log as well. The connector can be also installed on the screw type joint device having a different transmission mechanism for rotating the fastening bolt as long as the device has a fastening bolt supported by the first element.

[0028] Driving an annular thorn formed on a contacting surface of the connector into the butt end of a log protects the butt end from deformation in the direction of the radius and circumference thereof since the end of a log is held by the thorn. There is no clearance left between the butt end and the annular thorn driven therein, so that the deformation of the butt end can be avoided perfectly and a strong connection of the connector to a log can be kept for quite a while. Big lag screw and/or plural screws available for wooden members facilitate a wooden truss

structure on a large-scale.

[0029]A log having non-constant sections, which is kept as an original figure with a little bend, is also applicable to a truss structural member as well as a machined log having a constant round section. Contacting the contacting surface of the second element to the butt end introduces an axial force uniformly into the whole of section of a log. The present invention is applicable to not only a bar having a round section but a bar having a square section that is sawn because wooden bar is available for a structural member as long as the thorn can advance into the butt end of the bar.

[0030]The second element of the connector independent on the first element can be fixed alone to the butt end of a log by lag screws, then, the first element never obstructs the rotation of a lag screw and an operational load necessary for a lag screw is lightened in the free space.

[0031]Removing a part of the circumference on the node side of any second member fixed on both ends of a log owing to machining assigns the log to an exact overall length easily. Accordingly, assembling the first member machined into the second member makes a log-made truss structural member with high accuracy by contacting the first element to the circumference on the node side of the second member. Changing the amount of the engagement of the first element with the second one can not only absorb the error occurred during the manufacture but can give another length to a truss structural member intentionally.

[0032]The center of the log is not required to be in exact alignment with

two connectors fixed to both sides of the log. The alignment with the connectors only is necessary, which can be processed easily in a well-equipped factory. As the butt ends of a log can be formed by just cutting them off, the woodworking does not essentially need high technique and great skill aiming at high precision.

[0033]Disposing an auxiliary thorny ring between the second element and the butt end of a log so as to surround the neck of lag screws makes the cracks caused by the advance of lag screw against the log and the stay therein end up inside an auxiliary thorny ring, so that the cracks will not spread on the whole butt end of the log. The auxiliary thorny ring independent of the second element is driven into the butt end before the second element is carried to the butt end. The auxiliary annular thorn formed on the contacting surface of the second element can be driven into the butt end while the lag screw advances into the log.

[0034]A screw type joint device, wherein a polygonal boss is equipped on the fastening bolt so as to transmit rotational torque by covering the sleeve thereon, having been generally applied to a structural member made of steel pipe, comes to be applicable to a truss structural member made of log by introducing a connector, which comprises a first element and a second one, into the joint device.

[0035]The fastening bolt may be a high tensile bolt already on the market, being resistible for a big axial load, in the case that it is made of standard products. Not only a portion of the screw may be used as a fastening threaded portion but a bolt head may be used as a stopper which reacts against the fastening force occurred during the engagement

of the fastening bolt with a connector node. Use of high tensile bolts on the market contributes to lower the manufacturing cost of fastening bolts.

[0036]Bonding a sole-made polygonal cylinder provided with a round bore around the shank of a high tensile bolt can easily supply a fastening bolt equipped with a boss made of a bolt on the market. A polygonal cylinder provided with a threaded aperture can be easily mounted and bonded around the threaded end of the counter-node side of the fastening threaded portion. The coating of an adhesive agent covering both sides of screw threads generates twice the uniting force as strong as the coating covering a cylindrical surface around the shank, for the former results in having a bonding area more than twice as wide as the latter.

[0037]The pin provided on the sleeve covering the boss can prevent the sleeve from coming off the fastening bolt by contacting the end of the counter-node side of the boss.

[0038]A screw type joint device, having a sleeve is provided with a slit extending along the longitudinal axis thereof and a fastening bolt is provided with a rod extending in the radial direction thereof through the slit for transmitting rotational torque to the sleeve, and having been applied to a structural member made of steel pipe in general, also becomes applicable to log-made truss structural member by introducing a connector comprising a first element and a second one into the joint device.

[0039]An elastic element biasing the fastening bolt toward a screw hole of the connector node and being disposed in the space of the first

element for accommodating a part of the fastening bolt retracted through the supporting hole, does not require a coiled spring to be disposed inside the small sleeve, which consequently, allows to mount the pin mentioned above on the sleeve.

### Brief Description of Drawings

[0040]Fig.1 is a sectional view of one side of an example of the log-made truss structural member according to the present invention.

[0041]Fig.2 contains two sectional views of the assembly comprising a high tensile bolt, a boss made of a polygonal cylinder and sleeve covering the boss; (a) is a case that includes a polygonal cylinder provided with a round bore therein and (b) is another case that includes a polygonal cylinder having a threaded aperture therein.

[0042]Fig.3 is a view for explaining the procedures to assemble the log-made truss structural member shown in Fig.1.

[0043]Fig.4 is a sectional view showing the progress of cracks at the butt end reinforced by an annular thorn; (a) is a case without auxiliary thorny ring and (b) is another case with auxiliary thorny rings.

[0044]Fig.5 is two sectional views in vicinity of a butt end reinforced by a metallic seat integrated with thorns.

[0045]Fig.6 is two sectional views in vicinity of a butt end reinforced by rings.

[0046]Fig.7 is a sectional view of a log-made truss structural member using a joint device and a connector of another configuration.

[0047]Fig.8(a) is a sectional view of a log-made truss structural member using a joint device and (b) is a conical shell of furthermore different configuration.

[0048] Fig.9 is a sectional view of a log-made truss structural member having butt ends reinforced by a mechanism belonging to prior art.

#### Best Mode for Carrying Out the Invention

[0049] A log-made truss structural member according to the present invention is disclosed referring to the drawings showing some examples, as follows. Fig.1 is a sectional view of one side of a truss structural, wherein a screw type joint device having a fastening bolt engaged with the screw hole of a connector node is provided at both ends of a log. The truss structural member 1 mainly has a log 2, a screw type joint device 3, a connector 4 and lag screws 5 advancing against the log so as to fix the connector to the butt end 2A of the log.

[0050] The joint device provided at both ends of the log 2 is a screw type device, having the fastening bolt 6 provided with a fastening threaded portion 6a and the sleeve 7 covering the fastening bolt so as to transmit rotational torque thereto and so as to slide the bolt in the axial direction thereof. The joint device 3A has the same mechanism of transmitting rotational torque as the joint device indicated in U.S. Patent no. 4,872,779, wherein a coiled spring (Referring to 32 in Fig. 9) is not installed on a shank of the fastening bolt 6, being different from the joint device of the U.S. patent.

[0051] The connector 4 comprises a first element 4A occupying one half of a node side thereof and a second element occupying another half, which engages with the first element. The connector is fixed to the joint device 3A which joins a truss structural member 1A to the connector node

8, and also is fixed tightly to the butt end 2A of the log 2 by means of a big lag or plural lag screws 5, enabling wooden truss structural members to be used in the construction of large-scale roofs and large-scale walls.

[0052] As mentioned above, the connector 7 comprises the first element 4A occupying one half of a node side thereof and the second element 4B occupying another half thereof, so that the screw type joint device used with steel pipe structural members can also be installed on logs, further, it can be installed on a screw type joint device 3B shown in Fig. 7 described later as long as the first element 4A can support the fastening bolt 6 of the device 3.

[0053] Even a log 2 only cut off e.g., 2 to 4 meters in length, is usable for a wooden structural member as long as both butt ends 2A are parallel to each other. Undersized holes 9 were drilled to advance lag screws 5 into the butt end 2A of such a log 2 previously. Though the holes result in generating a reduction of sectional material in the log 2, the engagement of the lag screws with the log promotes the integration with each other, resulting in filling the reduction of sectional material with lag screw and in recovering the original strength of the log.

[0054] All of a round machined bar, a barked log and an original log with a little bend may be used as a structural member. However, it is required that the joint devices 3A and 3A be installed on both ends of the log by using the connectors 4 and 4 and these should just be in alignment.

[0055] The screw type joint device 3 is explained as follows. A fastening bolt 6 has not only a fastening threaded portion 6a at the end of a node

side thereof but a stopper 6s contacting the internal end surface of the first element 4A on the counter-node side thereof. The rotational torque is transmitted to the fastening bolt 6 by covering the hexagonal boss 6p formed on the shank of the bolt with the sleeve 7, which is provided with the sleeve hole 7a so as to slide the fastening bolt 6 in the direction of axis thereof.

[0056]The stopper 6s reacts on the fastening force by preventing the fastening bolt 6 from advancing more, resulting in achieving the tight fastening of the joint device and a connector node. A high tensile bolt on the market is used as a fastening bolt 6, and bolt head thereof is assigned to the stopper 6s mentioned before as shown in the drawing. The fastening bolt is obtained by using a bolt on the market is as follows.

[0057]The joint device 3A is provided with an elastic element 10 disposed in the space 4s mentioned below to bias the fastening bolt 6 toward a screw hole of the connector node 8. The pin 11 for preventing the sleeve 7 from coming off a fastening bolt 6 by contacting the end of counter-node side of the boss 6p can be equipped on the device because the coiled spring 32 disposed inside the sleeve 7 shown in Fig.9 is not applied to the present embodiment. The pin 11 is inserted into a small hole drilled into the sleeve beforehand after covering the boss 6p with the sleeve 7.

[0058]A spring plate 10A is used as the elastic element mentioned above, always pushing the stopper 6s. This plate 10A deforms as shown by the broken line when being pressed toward the counter-node side by pushing the projecting part of the fastening threaded portion 6a into the sleeve 7



so as to dispose the structural member into the un-expandible space between two connector nodes occupying the final positions, thereby, automatically restoring the spring plate 10A owing to the release of the force acting on the fastening bolt 6a staying in the sleeve 7 making the initial engagement of the fastening threaded portion 6a with a screw hole 8a of the connector node very easy after meeting each other. The truss structure that is equipped with the joint devices without elastic elements, see the device 3C shown in Fig.8 explained later, is inexpensively usable when disposing the structural member into expandible space between movable connector nodes.

[0059]The connector 4 holds not only the fastening bolt 6 slidably at the end of a node side but in the vicinity of a periphery of the butt end 2A at the end of a counter-node side, because of having a hole 4a for supporting the fastening bolt 6 on the node side and a contacting surface 4b which is seated on most of the butt end 2A on the counter-node side. An annular thorn 4c formed near the periphery of the contacting surface reinforces both sides of the log 2 by being driven into the butt end, resulting in preventing the butt end from cracking and chipping for quite a while. The reinforcement according to the connector becomes effective against the butt end in the direction of not only radius but circumference as well, resulting in restraining the butt end from cracking and expanding during the advance of lag screws thereinto and in contributing to a tight and long-lived connection of the connector and the log. Big lag screw and/or plural screws are available for wooden members and facilitate a wooden truss structure of large-size.

[0060]The first element 4A of the connector 4 is provided with the

supporting hole 4a which enables the shank 6m of the fastening bolt to move slidably at the end of a node side, and with a conical shell having an opening widely expanding toward the counter-node side thereof as a whole, wherein a space 4s for accommodating a part of the fastening bolt 6 retracted through the supporting hole on the side of counter-node thereof is formed, and a connecting threaded portion 4d is formed at the inside of the axial symmetrical part regulating the space on the counter-node side.

[0061]Holes 4e may be formed on the conical shell 4A for lightening itself under the condition that the joint device 3A is not exposed to moisture and/or raindrop. The spring plate 10A mentioned above is welded to the inner surface of the axial symmetrical part regulating the space after inserting the fastening bolt 6 into the first element 4A.

[0062]The second element 4B, which is engaged with the conical shell 4A, has not only a contacting surface 4b which is seated on the butt end 2A but an annular thorn 4c driven into the butt end at the circumference thereof. The annular thorn, being about 2 millimeters high, can be shaped easily by slightly digging the contacting surface 4b during manufacturing of metallic seats 4B. The annular thorns 4c for preventing the butt end from being damaged advance into the log easily owing to pressing the second element 4B to the butt end 2A by a hydraulic press. Since no clearance remains between the annular thorns and the log, the butt end can be held perfectly. The annular thorns may be driven into the log by using the force occurred during the advance of the lag screws 5. The fastening force generated by the propulsion of the lag screw 5 always prevents the annular thorns 4c from loosening.

[0063]A threaded part 4g engaging with the first element 4A is formed on the shrunk periphery occupying a half part of the original periphery of the second element 4B provided with bores 4f for positioning the lag screws 5. The axial force introduced into the first elements 4A through the connector nodes 8 and joint devices 3A is transmitted to the butt ends 2A through the second elements 4B having the flat contacting surfaces seating on the butt ends 2A under the constant and uniform distribution.

[0064]Since plural bores 4f of the second element 4B may accept the number of the lag screws 5 selected in response to the difference of characteristics of the log within the number thereof, many of the connectors 4 are usable for logs with different size, resulting in a decrease of cost according to the mass production. Keeping the adjustable portion 4h between the shrunk periphery and original one mentioned above may compensate to assign the exact length L2 to the main body of a structural member if increasing the size of the shrunk periphery by machining in the state that the second elements 4B is fixed to both ends of log 2, so that the log-made structural member 1A is assigned to the overall length L1 with high accuracy because both the first element 4A and the sleeve 7 are, of course, machined products.

[0065]A cutting error margin of a log may be compensated by the adjustment of engagement of the first element 4A with the second element 4B, which is different from the above-mentioned. The length of a truss structural member can also be changed on purpose by adjustment owing to the same procedures. The inevitable errors occurring during the manufacture of wood products can be absorbed depending on the

process to assemble metallic parts which can be produced with accurate size. Since the screw type connection is applied to all parts except a log, the deterioration and the change in dimension of the installation portion of the joint device can be avoided. In addition, the assembling work becomes much easier.

[0066] In Fig.1, auxiliary thorny rings 12 are used with an annular thorn, which reinforces the circumference of every neck of lag screw 5 on the butt end 2A individually. If the auxiliary thorny ring is a single part, a pipe of e.g., 0.6 millimeters thick can be used by cutting 4 millimeters wide, the ring driven into the portion around the opening of hole 9 for the lag screws 5 by a hydraulic press, as discussed above.

[0067] Since bolts on the market do not come with a polygonal boss, a high tensile bolt will require the polygonal boss in the case that adoption of standard industrial products are desired for manufacturing the fastening bolts 6. Bonding the polygonal cylinder 13 having a round bore 13a as shown in Fig.2 (a), which is manufactured as a sole part, around the shank 6m of the fastening bolt with adhesive agent 14 integrates a polygonal boss 6p with the bolt. A polygonal cylinder 13 provided with a threaded aperture 13b as shown in Fig.2 (b), can be easily mounted and bonded around the threaded end of counter-node side of the fastening threaded portion 6a. The coating of adhesive agent covering both sides of the screw threads generates twice as strong of a uniting force as the coating covering a cylindrical surface around the shank, resulting in improved bonding durability.

[0068] The truss structural member 1A mentioned above is assembled as

indicated in Fig.3. The log 2 is cut so as to form flat surfaces on butt end 2A thereof, and is drilled so as to make the undersized bores 9 in the butt end, the hole threaded by a tapping screw if necessary. The auxiliary thorny rings are driven into the butt end 2A to surround the opening of the undersized holes. The second element 4B is carried to the butt end, simultaneously, to engage the annular thorn 4c with the butt end 2A by a hydraulic press. The lag screws 5 advancing against the undersized bore 9 through the hole 4f press the metallic seat 4B toward the butt end 2A, so as not to loosen the annular thorn as well as the auxiliary annular thorny rings 12 by means of the contacting surface 4b. The adhesive agent may be applied to the lag screws before they advance into the log.

[0069] The head of lag screw 5 occupies a part of the open space 15, as shown in Fig.5(a), for instance, as described later, so as not to interfere with each other while driving the screws, even if plural screws 5 are used since the conical shell 4A of the first element is still not installed on the metallic seat 4B when driving the lag screw 5. The adjustment of the length of the member is performed by cutting the adjustable portion 4h, see Fig.3, if necessary, after the second elements 4B are fixed to both ends of log 2.

[0070] The high tensile bolt 6A is inserted into the supporting hole 4a of the first element 4A, and a polygonal cylinder 13 is bonded around the threaded portion 6a or the shank 6m of the bolt, which are projected from the sleeve toward the node side as shown in Fig.2(a) and (b). The pin 11 is driven into the sleeve 7 after the fastening bolt 6 with the boss 6p is covered with the sleeve. Finally, the threaded portion 4d of the first element 4A is engaged with the threaded part 4g of the second element

4B, resulting in obtaining a truss structural member 1 made of a log as shown in Fig.1.

[0071] The introduction of the annular thorn into the joint device not only allows the log to be cut off easily without high accuracy but allows to use a big lag screw or plural lag screws. As a result, a structural member becomes strong in resisting the large axial force in spite of the fact that the main body of the member is just made of a log. Beside, great technical skill for installing the screw type joint device on the log is not required, and the process for reinforcing the butt end owing to an annular thorn merely depends on the driving, resulting in holding the butt end tightly due to the annular thorn without slack.

[0072] Holding the butt end 2A by the annular thorn 4c restrains the cracks 16 from growing around the hole 9 as shown in Fig.4 (a). Even if the cracks reach the annular thorn 4c, further growth will be restricted to the region surrounded by the annular thorn. As shown in Fig.4(b) drawn corresponding to Fig.1 the expansion of cracks 16 stay only around the lag screw 5, resulting in restraining the cracks from progressing as possible according to dual-barrier system consisting of the annular thorn 4c and the auxiliary thorny ring 12.

[0073] The threaded portion 4d and the threaded part 4g, see Fig.1, may be engaged tightly with each other by bonding. Also, the direction of threaded spiral assigned to such portion and part may be opposite to that assigned to the fastening threaded portion 6a and screw hole 8a of a connector node engaging with each other. Joining truss structural members 1 to connector nodes 8 facilitates the engagement of the

threaded portion with the threaded part, resulting in elimination of the slack occurring between the threaded portion and the threaded part.

[0074] Using the mechanism where the direction of spiral of the connector at one side of the log is opposite to that at the other side enables the length of the truss structural member to be adjustable to match with the pitch of two connector nodes to be joined. Only rotating a log can continuously change the distance between the connector nodes of both right and left sides, similar to a movement of a well-known turnbuckle, even if the length of the truss structural member is different from the distance between two connector nodes.

[0075] A small screw 4p threaded as shown in Fig.1 may prevents the connector from slacking. Releasing the small screw allows the disconnection of connector 4, enabling the reuse not only of the joint devices but of the connectors, even when replacing the logs.

[0076] In Fig.1, the annular thorn 4c is formed on the contacting surface 4b of the second element 4B. The auxiliary thorny ring 12 is a dowel independent of the second element 4B. As shown in Fig.5(a), however, an auxiliary annular thorn 12c, corresponding to the auxiliary thorny ring, may be formed on the contacting surface 4b. These two kinds of thorns are driven into the butt end 2A. In addition, as shown in Fig.5(b), the auxiliary annular thorn 12c may only be equipped on the connecting surface 4b.

[0077] Fig.6 contains two examples where only auxiliary thorny rings are used instead of an annular thorn. Fig.6 (a) is an example including a

large thorny ring 17 holding the whole butt end and small thorny rings 18 surrounding each lag screw and Fig.6(b) is an example having a large thorny ring 17 only. Any thorny ring would be a sole or unitary part, therefore, any ring having a proper width in response to the required driven depth can be selected as necessary.

[0078] Fig.7 is an example where the truss structural member 1B is equipped with a joint device 3B having another composition. The joint device 3B has the same mechanism of transmission of rotational torque as the joint device described in German Patent No.901,955. However, this is different in that the coiled spring 10B biasing the stopper 6s is installed in the conical shell 4C. With regard to the details of the joint device, this has the slit 7b extending along the longitudinal axis on the sleeve 7A and a rod 7c for transmitting rotational torque is mounted on the fastening bolt 6 through the slit. Accordingly, a polygonal boss is not required on the fastening bolt 6, and a high tensile bolt 6A already available on the market can be used without modification. Furthermore, the coiled spring 10B can be also be used in the device shown in Fig.1, instead of a spring plate 10A.

[0079] In Fig.1, the threaded portion 4d engaging the first element 4A with the second element 4B is an internal thread. On the other hand, in Fig.7, the threaded part of the second element 4D is an internal thread 4g and the threaded portion of the first element 4C is an external thread 4d, so that a groove which receives the tip of conical shell 4C is formed in the second element 4D. Either configuration of the connector for integrating the first element with the second element may be used.



[0080] Fig.8 is an example of the log-made truss structural member 1C provided with the joint device 3C having fastening bolt 6 which can not automatically restore, wherein the joint device is the same kind as the joint device 3A in Fig.1 except for the absence of an elastic element. The characteristic of such a truss structural member is that the base part 4j of the cylindrical second element 4F is kept flat to contact tightly the butt end 2A. Also, the threaded part 4g engaging with the first element 4E is formed at the end of the inner wall of the cylindrical part 4F opening at the end of a node side.

[0081] Also, in the case where the second element 4F is cylindrical, this can be fixed to the log 2 easily if the lag screws 5A with a head 5a having hexagonal hole 5b are applied to the element. Of course, the hexagonal hole is not necessary when the cylindrical space 4t is large enough to use a socket wrench.

What is claimed is: